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INSECTICIDAL VALUE OF CERTAIN DUSTS FOR THE PROTECTION OF STORED GRAIN

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Primitive agriculturists employed many curious devices for protecting stored grain from the depredations of insects . The use of a protective covering of dust, wood ashes, or similar finely divided material, or the mixing of the material with grain to prevent insect damage, is an ancient practice that has never been abandoned.

Recent attempts have been made in this country to popularize the use of a foreign product, consisting of pure quartz sand ground to a fine powder, for preserving stored wheat from insect attack. When mixed with grain at the rate of 1 per cent by weight, it is reported to cause the death of all grain-infesting insects in a few days. According to Germar (1936) the dust causes the death of insects by depriving them of moisture. The dust is not hygroscopic, but it adheres tightly to the insect and by capillary action conducts the body moisture to the air, which takes up this moisture. The dust therefore acts merely as a conductor of moisture, and the dryness of the surrounding air is an important factor. Kunike (1936), however, discounts the rather glowing reports of the insecticidal action of this product by pointing out that various German authorities tested it with inadequate results and that Germar did not prove its efficiency with large lots of grain.

To mix powdered sand with grain at the rate of 600 pounds per 1,000 bushels and then remove the sand would seem to make the treatment impractical from a purely economic viewpoint, since other treatments would be much cheaper. It was felt desirable, however, to determine the efficiency of the dust as an insecticide and its effect on the grain.

Five 1-kilogram samples of wheat with a moisture content of 16 per cent were placed in glass jars. Four of the samples were treated with the finely ground sand at the rate of 1 per cent by weight, and into each jar were introduced adults of the rice weevil, lesser grain borer, and cadelle, and adults and eggs of the flour beetle. The jars were set aside at room temperature and humidity for 84 days, after which they were examined. As shown in table 1, the insects bred in the untreated grain with greater freedom than in the treated grain, but the sand did not prevent them from breeding in large numbers.

Table 1.—Development of insects in various wheat samples following treatment with finely ground sand at the rate of 1 per cent by weight.

Species and Stage	No. of Insects Introduced into each Sample	Number of Insects Found After 84 Days									
		Sample 1		Sample 2		Sample 3		Sample 4		Check	
		Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
Rice weevil											
adults	20	1,640	120	2,500	96	1,390	106	1,325	150	5,400	200
Lesser gr. borer											
adults	20	62	17	40	10	32	12	52	13	36	14
Cadelle											
Adults	8	0	8	0	8	0	8	0	8	3	5
Larvae	-	34	0	40	5	13	8	34	8	50	11
Flour beetle											
Adults	20	165	32	110	39	81	9	105	24	48	10
Larvae	-	6	-	9	-	7	-	0	-	16	-
Eggs	20	-	-	-	-	-	-	-	-	-	-

Some of the wheat that had been treated with the dust at the rate of 1 per cent by weight and cleaned by the process ordinarily used in flour mills was ground into flour. Commercial cereal chemists examined this flour and found that the treatment had produced no deleterious effect.

Similar tests were conducted with an activated pyrophyllite (325-mesh pyrophyllite with the thinnest possible coating of aluminum fluoride) of domestic origin. The chemical analysis of the material as given by the manufacturer is as follows: SiO_2, 75.4 per cent; Al_2O_3, 20.4 per cent; Fe_2O_3, 0.3 per cent; K_2O, CaO, and Na_2O, 0.4 per cent, and H_2O, 3.5 per cent.

Eighteen 1-kilogram samples of wheat having a 16-per cent moisture content were placed in ½-gallon glass jars and each was infested with adults of the rice weevil and cadelle as well as adults and eggs of the flour beetle. Four samples were treated with the dust at the rate of 1 pound per bushel of grain, or 1.66 per cent by weight, and four at twice that dosage. Two weeks later four of the remaining samples were treated at the rate of 1 pound per bushel and four at 2 pounds per bushel. The remaining two samples were left untreated. Approximately 2 months later all samples were examined and a record was made of the living and dead insects found. From the data in table 2 it may be seen that the pyrophyllite also exerted a slight inhibiting effect upon the development of some of the insects, although this effect was not sufficient to be of economic value.

The results obtained with the finely ground sand and the pyrophyllite suggested the probability that the moisture content of the wheat had considerable influence on the effectiveness of the dust and

that doubtless the many conflicting reports of the effectiveness of various dusts in protecting stored grain were due to variation in the moisture content of the grain used by the investigators. It has long been known that grain low in moisture content is unfavorable for

Table 2—Development of insects in wheat treated with pyrophyllite.

Species and Stage	Number of Insects Introduced on each Sample	Number of Insects Found After Approximately 2 months					
		1.66 Per Cent Dosage		3.33 Per Cent Dosage		Check	
		Live	Dead	Live	Dead	Live	Dead
Samples Treated Immediately[1]							
Rice weevil adults	20	322	27	123	36	694	27
Cadelle							
Adults	8	0	8	0	8	4	4
Larvae	-	11	1	63	0	222	3
Flour beetle							
Adults	20	11	13	6	16	11	4
Larvae	-	38	-	60	-	4	-
Eggs	20	-	-	-	-	-	-
Samples Treated After 2 Weeks[2]							
Rice weevil adults	20	422	57	209	99	263	21
Cadelle							
Adults	8	0	8	0	8	3	5
Larvae	-	69	0	44	0	231	1
Flour beetle							
Adults	20	7	12	3	17	8	4
Larvae	-	44	-	57	-	3	-
Eggs	20	-	-	-	-	-	-

[1]Developmental period for 1.66% dosage 68 days, 3.33% dosage 57 days, and check 68 days.

[2]Developmental period for 1.66% dosage 54 days, 3.33% dosage 42 days, and check 57 days.

insect development, and with the use of small samples their natural desiccation under normal laboratory conditions would tend to make them unfavorable to insects, regardless of whether or not they were treated. Claus (1939) recently observed that the successful eradication of the granary weevil from grain by treatment with finely ground sand is not possible, at least in damp coastal districts. Undoubtedly the grain in such regions has a high moisture content.

To determine the validity of this theory, tests were conducted with a number of common dusts, most of which have been recommended at one time or another for the protection of stored grain from insect attack. The materials tested, together with the proportion in which they were mixed with wheat, are listed in table 3.

Samples of 350 and 1,000 grams containing wheat with moisture contents of 10, 12, and 16 per cent were treated with each of the materials, and samples were left untreated as checks. The samples were infested with rice weevil and flour beetle adults. They were then placed in tightly closed mason jars and set aside for incubation. A record of the insects found is given in Table 3.

Table 3.—Efficiency of various dusts in protecting stored wheat from insect attack.

Dust and Dosage	Moisture Content of Wheat, Per Cent	Size of Sample, Grams[1]	No. of Insects Found at Time of Examination[2]				
			Rice Weevil Adults		Flour Beetle Adults		Flour Beetle Larvae,
			Live	Dead	Live	Dead	Live
Borax 1%	10	350	0	10	0	10	0
		1,000	0	20	0	20	0
	12	350	0	10	0	10	0
		1,000	0	20	0	20	0
	16	350	0	39	0	10	0
		1,000	0	92	0	20	0
Soybean flour 1%	10	350	6	11	104	5	93
		1,000	19	21	185	7	124
	12	350	2	10	81	7	47
		1,000	11	24	174	18	95
	16	350	2,684	68	96	11	89
		1,000	5,726	127	196	24	94
Soybean flour 2%	10	350	10	14	90	4	68
		1,000	27	28	142	8	94
	12	350	6	12	49	8	32
		1,000	14	28	109	16	68
	16	350	3,841	94	114	18	85
		1,000	5,841	142	237	43	103
Sulfur 1%	10	350	4	11	17	10	2
		1,000	14	21	28	16	14
	12	350	0	10	0	10	0
		1,000	8	24	5	18	0
	16	350	2,643	167	87	18	66
		1,000	4,895	186	184	47	42
Sulfur 2%	10	350	0	10	1	9	11
		1,000	5	24	6	18	3
	12	350	2	16	0	10	0
		1,000	19	38	4	27	0
	16	350	2,416	78	94	17	72
		1,000	4,432	147	162	42	25
Lime 1%	10	350	0	10	0	10	0
		1,000	0	28	4	16	0
	12	350	0	10	1	9	0
		1,000	7	36	1	19	0
	16	350	475	116	3	34	0
		1,000	842	187	31	45	2

Dust and Dosage	Moisture Content of Wheat; Per Cent	Size of Sample, Grams[1]	No. of Insects Found at Time of Examination[2]				
			Rice Weevil Adults		Flour Beetle		
					Adults		Larvae,
			Live	Dead	Live	Dead	Live
Lime 2%	10	350	0	10	0	10	0
		1,000	0	20	3	17	2
	12	350	0	10	0	10	0
		1,000	0	20	0	20	0
	16	350	68	179	0	10	0
		1,000	25	164	0	20	0
Wood ashes 1%	10	350	1	9	46	11	6
		1,000	18	13	92	10	36
	12	350	2	17	17	10	12
		1,000	18	24	103	18	67
	16	350	482	25	106	14	79
		1,000	3,542	121	208	36	92
Wood ashes 2%	10	350	1	9	26	9	2
		1,000	14	16	64	11	18
	12	350	3	18	10	8	2
		1,000	0	20	98	14	42
	16	350	164	27	79	9	68
		1,000	3,731	97	126	32	86
Check	10	350	17	11	15	2	7
		1,000	49	22	97	6	43
	12	350	29	14	8	2	0
		1,000	51	14	74	11	11
	16	350	3,672	125	85	14	78
		1,000	5,678	214	82	34	97

[1]350-gram samples each infested with 10 adult rice weevils and to adult flour beetles and 1,000-gram samples with 20 of each insect species.

[2]Samples of wheat with a 10-per cent-moisture content were examined after 87 days and the other samples after 112 days.

Wood ashes and soybean flour had no appreciable effect in preventing insect development. Sulfur dust was slightly affective with 10- and 12-per cent-moisture wheat, but in the 16-per cent-moisture wheat treated with this dust insect development was almost as rapid as in untreated wheat of the same moisture content. Lime showed good protection for 10- and 12-per cent-moisture wheat and some protection for 16-per cent-moisture wheat, although not adequate for practical purposes.

With the exception of the wheat having a 16-per cent-moisture content, there was no increase in infestation in the samples treated with borax, and no life was apparent in any of the samples at the time of examination. It would seem therefore that treatment with 1 per cent by weight of borax is adequate protection for stored grain against insect attack. Unfortunately its use cannot be recommended,

since it is absorbed by the grain.

Insect development varied among the different untreated samples of wheat. Development was exceedingly slow in that of 10- and 12-per cent-moisture content but rapid in wheat of 16-per cent-moisture content.

A number of poisonous dusts have been recommended from time to time for the protection of stored seeds from insect attack and there is little doubt that many of them are highly effective. They are, however, of value only in protecting grain that is intended for seeding purposes, and it is doubtful whether they should even be recommended for this purpose owing to the chance that treated grain may accidently be used for food.

According to the results of these studies it does not seem likely that adequate protection from insects can be obtained for stored grain by admixture with dusts other than those which are poisonous or which exert some deleterious effect on the grain.

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DISTRIBUTIONAL RECORD FOR NOTONECTA HOFFMANNI HUNGERFORD 1925

In the study of some **Notonecta** taken by the Kansas Biological Survey party during the summer trip of 1936, the following distributional record was found worthy of note.

Five specimens, three males and two females, bear the label Silver City, New Mexico, July 22, 1936, collected by R. H. Beamer and M. B. Jackson. These specimens were typical of **Notonecta hoffmanni** Hungerford in every way.

This species has previously been recorded from Lower California, western Mexico, and Arizona.

R. I. SAILER

MEGABOTHRIS ABANTIS (ROTHSCHILD): DESCRIPTION OF THE FEMALE. (SIPHONAPTERA).

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1905. **Ceratophyllus abantis** Rothschild, Nov. Zool. 12:164-165, pl. 6, fig. 10 Described from two males, one from **Putorius longicaudatus** (now **Mustela frenata longicauda**), Canadian National Park, Alberta, and one from **Microtus drummondi**, Horse Creek, Upper Columbia Valley, British Columbia.

1933. **Megabothris abantis** (Rothschild), Jordan, Nov. Zool. 39:77.

Female: head:—The upper or frontal row contains 5, occasionally 4 or 6, bristles and the lower or ocular row contains 3, rarely 2, long bristles. On the occiput there are 3 bristles in addition to those of the marginal row. Along the rear margin of the antennal groove there is a single row of setae. The 5-jointed labial palpus reaches nearly to, sometimes to, the apex of the fore coxa. The maxillary palpus extends to or slightly past the base of the last joint of the labial palpus.

Thorax:—The pronotal comb consists of 19 to 21 spines, of which the lower one on each side is usually very much reduced, there being 18 or 19 normal sized spines. There is only one row of bristles on the pronotum in front of the pronotal comb. The metanotum may or may not bear one very small apical spinulet.

Abdomen:—The abdominal tergites bear apical spinulets as follows (average, minimum and maximum on each side, respectively): I=1(0—2); II=2(1—2); III=1(1—2); IV=1(0—1).

Modified segments:—There are 3 antepygidial bristles (Ap. br.), the average lengths of which are:—upper or inner=0.08 mm.; middle =0.24 mm.; lower=0.08 mm. The antepygidial stigma (Sti.) is large, measuring on an average 0.09 mm. in length (= height), by 0.05 mm. in width. The upper margin of the pygidium (Pyg.) is very slightly concave. The stylet (Sty.) is short, thick on the basal half and with the margins convex. It averages 0.053 mm. in length by 0.026 mm. in greatest diameter. It bears one long terminal bristle about 3 times as long as the stylet, and 2 or 3 lateral bristles. The posterior margin of the 7th sternite is without a sinus. It is produced backward into a short, broad lobe starting slightly above the base of the posterior margin. The rear margin of this lobe may be either regularly rounded or somewhat irregular. The 7th sternite bears a principal row of 4 to 6 bristles, in front of which there are from 3 to 9 smaller bristles. The 8th sternite is fairly long, but narrow. The posterior margin of the 8th tergite is irregularly rounded with a small lobe on its upper part. The 8th tergite bears 2 long bristles below the stigma, and from 13 to 19 bristles of various sizes nearer the lower margin. The 10th sternite is angulate, the

postero-ventral margin armed with a large number of spines and bristles. The head of the receptaculum seminis (R.s.) is cylindrical, measuring on an average 0.115 mm. in length and 0.062 mm. in width, and is rather heavily chitinized. The tail of the receptaculum seminus is bent at an angle of from 90° to 120° with respect to its head, and is moderately chitinized toward the rounded apex. It is parallel sided and averages 0.93 mm. in length by 0.028 mm. in diameter. The duct of the receptaculum seminis (D.r.s.) (in contrast to Jordan, 1929, Nov. Zool. **35**:33)[1] is not conspicuous, being small and lightly chitinized. The bursa copulatrix is fringed anteriorly with ramnifying ducts but is not heavily chitinized at any point.

Length:—2.57 (1.9—3.4) mm.

Allotype female collected from **Citellus columbianus**, Deer Lodge County, Montana, on Georgetown Lake shore, elevation 5,700 feet, August 10, 1928, by Montana State Plague Survey field crew, and deposited in the collection of the United States Public Health Service, Plague Suppressive Measures Laboratory, San Francisco, California. The above collection contains the following additional specimens of this species, all collected by the field crews of this laboratory and of states cooperating in Plague survey work.

Oregon: Grant County, from **Citellus beldingi oregonus**, 1 female; from **Citellus columbianus**, 1 male; Wallowa County, from **Citellus columbianus**, 1 female.

Idaho: Latah County, from **Citellus columbianus**, 1 female; Caribou County, from **Citellus armatus**, 1 female.

Montana: Flathead County, from **Sciurus hudsonicus richardsoni**, 1 female; Granite County, from **Citellus columbianus**, 1 male; Beaverhead County, from **Citellus richardsoni elegans**, 1 female; from **Citellus columbianus**, 1 male; from **Eutamias** sp., 1 male; Jefferson County, from **Citellus columbianus**, 1 female; Madison County, from **Citellus richardsoni elegans**, 1 female; Meagher

[1]Wagner 1936 (Ziets.f.Parasit. **8**:656, text-fig. 3), describes **M. adverus**; from a single female with a very lightly chitinized duct of the receptaculum seminis, as a new species, separating it from **M. abantis** largely on the basis of Jordan's statement. The writer has examined 33 females of **M. abantis** from 6 western states, several of them in the same lots as males of this species, and finds this duct to be inconspicuous in all of them. On the other hand, this duct in **M. lucifer** (Roths.) 1905, is large, heavily chitinized and conspicuous. Since the female of **M. lucifer**, being described by Rothschild, was available to Jordan, while that of **M. abantis** was then undescribed, it is quite possible that Jordan intended to write "**C. lucifer**" instead of "**S. abantis**" (sic). If this is the case, Wagner's **M. adversus** has been created due to an error. In any case, the writer can find nothing in Wagner's description or figure which separates **adversus** from **abantis** and therefore considers it to be very probably a synonym of **abantis.** He has not seen the monotype of **adversus**, however, and so cannot make a final decision on the matter.

County, from **Mustela arizonensis**, 4 males and 2 females; Park County, from **Citellus richardsonii**, 2 females; from **Citellus armatus**, 1 female; from **Marmota flaviventris**, 1 male; from **Ochotona princeps**, 1 female; Fergus County, from **Rattus norvegicus**, 1 male; Yellowstone National Park (Mont.), from **Glaucomys sabrinus**, 1 female;

Wyoming: Yellowstone National Park, from **Microtus pennsylvanicus**, 3 females, and from **Zapus princeps**, 1 male, 2 females; Park County, from **Sylvilagus auduboni**, 1 male, and from **Citellus armatus**, 1 female; Teton County, from **Citellus armatus**, 2 males, 1 female; Lincoln County, from **Citellus armatus**, 1 female, from **Peromyscus** sp., 1 female, and from **Mustela arizonensis**, 1 female; Uinta County, from **Mustela** sp., 1 male, 1 female;

Utah: Uintah County, from **Citellus lateralis**, 1 male and from **Mustela arizonensis**, 1 female; Wasatch County, from **Mustela arizonensis**, 1 male;

Colorado: Routt County, from **Eutamias minimus**, 1 female; Grand County, from **Citellus richordsonii elegans**, 1 male.

The following additional specimens of this species, from the collection of the Rocky Mountain Laboratory, U. S. Public Health Service, have been examined by the writer:—

Oregon: Morrow County, from **Citellus columbianus**, 1 male;

Montana: Ravalli County, from **Sciurus hudsonicus**, 2 males; from **Citellus columbianus**, 1 female; Glacier National Park, from Coyote, 1 female; Madison County, from **Citellus** sp., 1 female, from **Mustela** sp., 1 female.

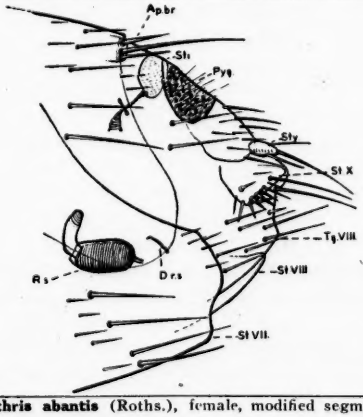

Figure 1. **Megabothris abantis** (Roths.), female, modified segments. X87.

Abbreviations.—Ap. br., antepygidial bristles; D.r.s., duct of the receptaculum seminis; Pyg., pygidium; R.s., receptaculum seminis; St., sternite; Sti., stigma; Sty., stylet; Tg., tergite.

SOME NEW SPECIES OF SYRPHIDAE

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In this paper I present the description of three new Syrphid flies from the neotropical region. Types are in the author's collection.

Rhysops pollinosa n. sp.

Related distantly to **Rhysops (Melanostoma) lineata** Fluke; **pollinosa** is characterized by the four facial grooves, the linear spots, the smoky wing tips.

Female. Length 9 mm. **Head:** front and vertex subopaque black, the former broadly divided transversely by yellowish-brown pollen; the face is pale greyish-yellow, almost white pubescent and with similar pile. There is a broad, shining, brownish-black middle stripe and a submedial, incomplete stripe partly bisecting the facial pubescence. There are four transverse facial grooves. The pile of front and vertex is black; the cheeks are bluish-black, the antennae missing. **Thorax:** mesonotum and scutellum bright brassy-black with obscure, brownish pollinose vittae. Viewed posteriorly the anterior half has a moderately separated stripe of light brownish-yellow pollen; elsewhere the pollen is dark brown, except on the lateral margins; scutellar margin with a pair of slender, pale bristles. **Abdomen:** elongate, the first segment shining black, the second shining blue-black with an obscure, diffuse, brownish-orange, elongate, sublateral spot along the outer portion of the segment; they are thus very widely separated and are equidistant from base and apex of segment. Third segment with quite similar, slightly smaller spots that begin at the base. Fourth segment, with smaller and similar basal spots. **Legs:** everywhere light orange-brown except the middle three anterior tarsal joints, last three middle and posterior tarsal joints, the broad middle of the hind tibiae, the apical half of the hind femora except its narrow apex, all of which are black. **Wings:** pale brown, darker near the apex; stigma dark yellowish-brown.

Holotype: one female, Sao Paulo, Brazil, Nov., 1940. (J. Lane, collector).

Rhysops lachrymellea

Related to **Rhysops (Melanostama) lanei** Fluke, but the abdominal spots reach widely over the margin, especially on the second segment.

Male. 7 mm. long. **Head:** vertical and facial pile pale, the latter broadly whitish pubescent along sides, leaving the anterior part of the cheeks and a broad middle stripe shining bare. This stripe is metallic black, violet margined; down this stripe for a short distance, as far as the single transverse groove, runs a stripe of pubescence; moreover,

dividing the lateral pubescent portion of the face is a stripe which by its shining, brassy color, obscures that part of the pubescence. Antennae elongate, light brownish-orange, the third joint two and one-half times as long as wide, and black at extreme apex and all along the dorsal edge. **Thorax:** mesonotum brilliant, metallic greenish-white There are a pair of broad stripes of pale yellowish pollen that are narrowly separated by dark brown pollen; lying outside of these are a pair of wider, dark brown pollen stripes. The lateral third of the mesonotum anteriorly is pale pollinose. Both thoracic pile and scutellar pile is pale brassy. The scutellum is bright, pale, greenish-brassy in ground color; its apex has a pair of slender bristles, black on their distal half. **Abdomen:** first segment metallic black; remaining segments shining sepia-black with spots of pale brownish-yellow as follows: large lateral spots on second segment separated by a third of segment's width and covering entire lateral margin but attentuated posteriorly; the pair of spots on third segment are larger, more narrowly separated, are oblong and somewhat oblique spots, that posteriorly diverge and turn out to the lateral margin in the middle of the segment; the basal corners of this segment are dark; fourth segment with quite similar spots which however, do not reach the lateral margin. **Legs:** first four legs light orange-brown except for the dark brown middle three tarsal joints of anterior pair and apex of their first joint. Hind legs blackish-brown, the base of hind femora narrowly and the hind basi tarsi orange-brown. Wings hyaline; stigma yellow.

Holotype: one male, Sao Paulo, Brazil, Oct., 1940. J. Lane, collector.

Meromacrus ceres

Related to **brunneus** Hull, but distinguished by the presence of the yellow, median thoracic stripe.

Male. Length 13 mm. **Head:** front and facial pile pale yellow, that of vertex black, of occiput yellow. Front, cheeks and a broad facial stripe shining black. The antennae are dark brown, the first joint black, the third longer than wide, rounded but subtruncate dorsoapically; arista pale. **Thorax:** mesonotum dull brownish-black with brownish-yellow tomentum as follows: a narrow but quite evident middle stripe which before the scutellum becomes a large, hollow-sided, yellow triangle; a narrow, transverse, sutural stripe evanescent at both medial and lateral ends, hence not continuous with the posterior end of the well developed, bright yellow, diagonal stripe that borders the humeri; the prescutellar stripe continues out toward the border of the post calli. Remainder of mesonotal, and all of scutellar pile save for a few scattered hairs and its yellow marginal pile, shining reddish-brown. Ground color of scutellum brown,

becoming darker at base and lighter toward apex. **Abdomen:** brownish-black covered with appressed pile which is except for tomentous markings hereafter described black on the third segment and chiefly shining reddish-brown over the broad second segment and over the fourth segment. The posterior middle of the second segment and post margin of the fourth segment has some black setaceous pile. Only the first segment has a conspicious transverse stripe of tomentum which however is evanescent some distance from the lateral margin. However on the base of the third segment there is a quite narrow, inconspicuous fringe of flat-lying yellow pile, narrow and evanescent, in the middle. **Legs:** the femora are shining black, the anterior four somewhat more brownish-black; all of the tibiae dark brown. The middle and hind tarsi are light brown on their dorsal surfaces, the anterior pair more blackish. All dorsal tarsal pile black. First four femora and tibiae and hind tibia wholly pale brassy pilose. The front and middle femora and their coxae and metasterum and hind coxae have long crinkly tufts of yellow-white pile. The hind femoral pile is pale upon its base and laterally, but is widely black distally both above and below. **Wings:** with anterior border and base dark brown, the costal cell dark brown; sinus of loop of third vein clear.

Holotype: one male. Received some years ago in miscellaneous material from Brazil.

BUTTERFLY RECORDS FOR KANSAS

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Thorybes confusis (Bell) Mr. William D. Field in his "Manual of the Butterflies and Skippers of Kansas" suggests that this species should be found in Kansas. We are pleased to record that a single perfect female of this species was taken in Sumner County, Kansas in June, 1941. Determined by H. A. Freeman.

Achlyodes thraso (Hubner) This species has been previously recorded from Kansas on the strength of a specimen taken in Riley County in July of 1921. We wish to record a second specimen taken in Sumner County during October of 1941.

Atrytone arogos iowa (Scudder) A single speciman of this species was taken in Sumner County, during June, 1941. Although it has been taken a number of times in other parts of the state, this is the first record for the South-Central area.

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THE LIFE HISTORY AND HABITS OF THE RING-LEGGED EARWIG, EUBORELLIA ANNULIPES (LUCUS) (Order Dermaptera)

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The ring-legged earwig, **Euborellia annulipes** (Lucas),[1] was first recorded in the United States by Rhen and Hebard (6) in 1902. Since that time it has been reported from numerous states including for the most part, south-eastern, south-central, mid-western and south-western states. In Canada it is known to occur in British Columbia. It has also been reported from Central and South America, several European countries, India, China, Japan, and a number of the islands of the Pacific and South Pacific regions.

In the early part of May, 1939, I found an infestation of **E. annulipes** in the basement of a feed building on the University of Nebraska poultry farm at Lincoln where the earwigs were observed to be feeding on grain and to some extent on stored grain insects. Apparently this is the first authentic record of its occurrence in Nebraska. In spite of the practically cosmopolitan distribution of this insect, there is little published information concerning its biology. A study of the life history and habits of this species was made by me at the University of Nebraska during 1939 and 1940 while a major student in the Department of Entomology.

ECONOMIC IMPORTANCE

The ring-legged earwig is of considerable economic importance in some areas. It may be destructive or, because of predatroy tendancies, it may be beneficial. It has been reported as a pest of Irish and sweet potatoes in storage (5), and as a nuisance in meat packing plants. Professor R. C. Smith of Kansas State College, recently told me that this earwig is a common pest of flour mills in Kansas. In tropical regions it is predaceous on a number of insect pests, preying upon the sugar cane leafhopper (**Perkinsiella saccharicida**) in Hawaii (7), on a weevil pest (**Cosmopolites sordidus**) of bananas in Jamaica (4), and on the larvae of an owlet moth (**Sesamia inferens**), a pest of sugar-cane in Japan (8).

REARING METHODS

The earwigs were reared in two kinds of cages. One was a plaster of Paris block with cells one-quarter inch deep cut into it and the whole surface covered with a glass plate, while the other

[1]I am indebted to Mr. A. B. Gurney of the U. S. D. A. Bureau of Entomology and Plant Quarantine for identification of the species and for information on distribution and economic importance, to Dr. H. D. Tate, Prof. M. H. Swenk, and other members of the University of Nebraska Department of Entomology for suggestions and criticisms on this paper.

was a one-fourth pint ice cream container. In the first type, the high humidity necessary for the development of the earwigs was maintained by placing the entire plaster of Paris block in a pan of water for a few minutes every day. Since the earwigs are nocturnal, the glass plate was covered with a sheet of paper to exclude light. These cages were satisfactory except that conditions were also ideal for the rapid growth of fungi in them which necessitated frequent cleaning.

The bottoms of the ice cream containers were covered with one-quarter inch layer of plaster of Paris which was kept moist to maintain a high humidity. The earwigs could not climb the waxed, sloping sides of the container and, except for some of the larger ones, could not chew their way out of it. In this type of cage fungous growth was at a minimum. A convenient surface for records and labels was provided by the cardboard covers of the containers. The food supply consisted largely of wheat.

The earwigs were reared in a laboratory where the temperatures fluctuated from approximately 65 degrees F. to 85 degrees F. The variation between the life history records of the fall reared earwigs as compared to the winter and spring individuals probably is due to differences in temperatures existing at these times.

DESCRIPTION

The ring-legged earwig has been well described by Blatchley (1). It is 12 to 15 mm. long, dark brown to black with the under surface yellowish brown. The legs are yellowish with the femora and tibia ringed with fuscous. The antennae are 16 jointed and black in color except for the third and usually the fourth segment from the apex which are white. The forceps of the male are contiguous at the base, strongly incurved with the right one more so and crossing over the left at its apex. The forceps of the female are only slightly and equally curved at the tips. The male has ten abdominal tergites, whereas the female has but eight.

The nymphs resemble the adults except in size. The earlier instars are more greyish than black and the fuscous markings on the legs are less prominent. The abdomen is ten segmented and the forceps are the same in both sexes. The most striking difference between the five different instars is the increase in the number of antennal segments. The antennae are 8 jointed in the first instar, 11 jointed in the second, 13 jointed in the third, 14 jointed in the fourth, and 16 jointed in the fifth. The antennal segments are black with the base and apex of each segment pale and in the first and second instars the penultimate segment is completely white while in the third, fourth, and fifth instars the third segment from the apex is white.

The eggs are approximately 1 mm. long and 0.8 mm in diameter,

ovate, creamy white in color, covered with a transparent shell, and later become brown in color and kidney shaped.

LIFE HISTORY AND HABITS

Adults. In general, the habits of **Euborellia annulipes** are similar to those of cockroaches. It is nocturnal, negatively phototropic, and an omnivorous feeder. Under natural conditions, it lives under litter of various types, under rocks, and similar places where shallow holes are excavated in the soil as a nest for the deposition of the eggs and the rearing of the young. This earwig probably does not overwinter out-of-doors in the northern part of its range.

Copulation may occur a day or so after the final nymphal moult. At the time of mating, the male, upon sensing the presence of a female, backs toward her. The tip of his abdomen is then manipulated in such a way as to make contact with the copulatory organs on the ventral surface of the abdomen of the female. Occasionally the male completely turns over in this effort. They remain in copulation for only a few minutes. Unlike **Forficularia auricularia** the forceps are not used in mating (3).

Although these earwigs mate frequently, only one union is necessary for the production of several clutches of eggs. Females have been observed to produce as many as six clutches of eggs from a single mating. In the tests described in this report, there was an average preoviposition period of 10.77 days (Table 1). The maximum number of eggs per female was 74, the minimum 22 and the average 47. DeGeer, in 1773, was the first to record the fact that female earwigs brood over their eggs like a hen and this observation has since been confirmed by other authors. The female of the ring-legged earwig also has this peculiar habit. Eggs are deposited in a hollowed-out cell in the earth, the oviposition period usually extending over a period of two or three days. The female remains over the eggs, guarding them carefully and occasionally cleaning them with her mouth. If the eggs are scattered about, she picks them up and carries them one by one in her mandibles to a single pile where she continues to guard them. She can effectively use her forceps for defense and will nip the fingers sharply if handled. It was observed several times that the female, if unduly disturbed, would eat her eggs, sometimes destroying the whole clutch.

Eggs. It has been stated by observers of other species of earwigs that eggs taken from the female would not hatch (2, 4). To check this observation, a clutch of newly laid eggs was divided into two groups. Twenty-five eggs were put into one cell of a plaster of Paris block and twenty-seven eggs were left with the mother in another cell in the same block. Of the twenty-five eggs in the first group, five hatched in seventeen days while the remaining twenty

eggs were destroyed by mold and did not hatch. All of the twenty-seven eggs left with the mother hatched on the same day as the motherless eggs. Since the eggs will hatch if kept under the proper conditions and protected from fungous growth, it seems evident that the female's association with the eggs following their deposition is in a protective capacity.

Eggs kept in a dry atmosphere showed evidence of severe dessication within three days and failed to hatch. When kept in a humid atmosphere, the eggs increased both in size and weight and changed considerably in shape. The average length of 324 eggs at the time of deposition was 0.845 mm. and the diameter 0.637 mm. Newly laid eggs were ovate in shape and creamy white in color, but as they developed they became kidney-shaped, grey or brownish in color and the developing embryo could be seen plainly through the transparent eggshell. One day before hatching, the average length of 153 eggs was found to be 1.02 mm. and the diameter 0.8 mm. which was an incrase of 0.175 mm. in length and 0.163 mm. in diameter. When first laid, the eggs averaged 0.367 mg. in weight and one day before hatching, the average was 0.812 mg. This increase of 0.445 mg. in weight probably was due to the absorption of water by the egg. The incubation period averaged 14.32 day in length. The hatching of a clutch of eggs usually covered a period of two or three days, although some clutches hatched completely in a single day.

Nymphs. The first meal of the newly hatched nymphs was its empty eggshell and later the exuvia often was eaten at the time of moulting. They readily eat wheat and other grains, usually first attacking the germ but finally consuming the entire kernel. At the time of moulting, the nymph emerged from its old skin through a split on the Y-shaped epicranial suture and along the median groove of the dorsal surface of the thorax.

Evidence indicates that a high humidity is essential for nymphal development. Four nymphs kept in a dry cage died in three days. Three successive generations of **Euborellia annulipes** were reared, one in the fall, one in the winter, and another in the spring. The spring-reared earwigs developed more rapidly than did the earwigs reared in the fall and winter, probably because of the higher temperature conditions prevailing then. The average nymphal period of spring-reared earwigs (March 20 to June 30) was 56.44 days with a maximum of 89 days and a minimum of 45 days. The average for 32 individuals reared in the fall (September 18 to February 8) was 83.23 days, the maximum 176 days and the minimum 57 days. The average for 15 individuals reared in the winter (February 8 to May 18) was 87.86 days, the maximum 94 days and the minimum 71 days.

Table 1.—Summary of the life cycle of **Euborellia annulipes** (Lucas).

Stage	Specimans observed	Maximum	Minimum	Average
	Number	Days	Days	Days
Preoviposition period	22	22	5	10.77
Egg	1231	19	9	14.32
First instar	168	20	6	10.60
Second instar	136	25	8	13.49
Third instar	116	25	5	16.17
Fourth instar	75	75	7	20.01
Fifth instar	50	68	8	29.54
Total nymphal	56	176	45	80.71
Egg to adult	56	190	61	95.03

PROPORTION OF SEXES

Of the 56 earwigs reared to maturity, 41 of them were females and 15 were males, a proportion of nearly 4 to 1. The majority of the earwigs collected under natural conditions were females.

LONGEVITY

The ring-legged earwig is long-lived in captivity. One female which became mature on November 16, 1939 was still living on June 21, 1940, 229 days later, at which time it was destroyed. Other individuals lived more than seven months in the adult stage. One female died, apparently of natural causes, at the age of 203 days and another at the end of 206 days.

FOOD HABITS

Euborellia annulipes feeds omnivorously but appears to have a preference for an insect diet. Whole wheat was used in most of the rearing, but the earwigs also ate other grains, potatoes, meat, lettuce, and both living and dead insects. To some extent they were cannibalistic, feeding on eggs, living and injured earwigs, and evidence indicated that the female often killed and ate the male. This cannibalistic tendency may have been due, in some degree, to the vegetable diet upon which they were reared.

Insects were captured and retained by means of the forceps. In one instance, a dermestid larva was dropped into the cage of a large female earwig. She immediately grasped it in her forceps and while still holding the struggling larva, she turned her body in a half circle and proceeded to eat it. Flies and other insects were caught and eaten in much the same manner.

REGENERATION

The ring-legged earwig regenerates lost or broken appendages. Earwigs with regenerated forceps have been collected under natural conditions and several were reared. In one case of left forcep

of an earwig in the third instar was cut off near the base. At the next moult the appendage had become normal in shape but was slightly smaller than the right forcep, and following final the moult, there was scarcely any detectable difference in size between the right and left halves of the forceps.

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HOST RECORD AND DISTRIBUTIONAL NOTE FOR DERAEOCORIS RUFIVENTRIS KNIGHT 1921 (MIRIDAE)

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Of the twenty-four specimens of this species found in the Francis Huntington Snow Insect Collection, eighteen were collected during the summer of 1938. This is of partciular interest for it was during this summer that Dr. R. H. Beamer and his Biological Survey Party attempted to study especially the insects associated with **Arctostaphylos** (bear berry). More important is the host record **Arctostaphylos pungens** H. B. K., found on eight specimens taken at Idyllwild, California, July 29, 1938 by R. H. Beamer.

From the remaining sixteen specimens which bore no host records the following localities are noted: Dales, Calif., June 28, 1935 (R. H. Beamer); San Jacinto Mts., Calif., July 21, 1921 (L. D. Anderson); Truckee, Calif., August 20, 1938 (R. I. Sailer); Towie, Calif., August 20, 1938 (L. W. Hepner); Canyonville, Ore., July 12, 1935 (R. H. Beamer); Jamesburg, Calif., Aug. 11, 1938 (R. H. Beamer).

It would seem likely that this species feeds on plant lice or other soft-bodied insects living on **Arctostaphylos**. As might be expected and is indicated by its specific name, this insect is largely reddish-brown, thus conforming with the reddish color of the branches and twigs of the bear berry bush.

This species had hithertofore been known from the type locality, taken June 28, San Diego County, California (E. P. Van Duzee).

*Contribution from the Department of Entomology, University of Kansas.

A REVISION OF THE GENUS CEROTAINIOPS CURRAN (DIPTERA; ASILIDAE)

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On the basis of three asilids which he collected in New Mexico, Brown (1897), described **Nusa abdominalis** and **Nusa similis**. McAtee (1919), incorrectly identified Arizona material as **abdominalis** and proposed **Nusa abdominalis atripes** for two other specimens, one from New Mexico and one from Arizona. Subsequent workers have afforded **atripes** specific rank. **Nusa** Walker was later found to be untenable for North American species (Ricardo, 1927), so that these and other species included in **Nusa** were then referred to the genus **Andrenosoma** Rondani. **Atripes** and **similis** are here shown to be synonyms of **abdominalis**.

Curran (1930), described **Cerotainiops rufiventris** as a new genus and species on a basis of two specimens from Arizona. **Rufiventris** is here shown also to be a synonym of **abdominalis**. The genus **Cerotainiops** is distinct from **Andrenosoma**, however, and is retained for **abdominalis** and two other species from the Southwest which are described as new.

Fifty-five specimens of **Cerotainiops** have been studied for this revision. These species are very fast fliers, which is probably responsible for their being poorly represented in collections. Those specimens of **abdominalis** which the writer has collected in southwestern Oklahoma were ground inhabitants which is unusual in this tribe. The flies were found under xerophytic conditions where it seemed unlikely that the larvae could occur in wood. Our knowledge of the Laphriine robberflies to date indicates that the larvae of these genera are found only in wood where they are predaceous on borers. This is particularly true of **Andrenosoma** to which **Cerotainiops** is most closely related.

For the loan of material and for the priviledge of examining types, the writer wishes to express his appreciation to Mr. Joseph Wilcox, Dr. R. H. Beamer, Dr. R. H. Painter, Dr. C. H. Curran, Dr. E. A. Chapin, Mr. C. F. W. Muesebeck, Dr. F. E. Whitehead, and to Dr. C. E. Mickel.

Cerotainiops Curran

1919. **Nusa** (in part) McAtee (not Walker), Ohio Jour. Sci., 19 (4): 244.

1930. **Cerotainiops** Curran, Amer. Mus. Nov., 415: 11.

1934. **Andrenosoma** (in part) Bromley, Ann. Ent. Soc. Amer., 27 (1): 84.

Cerotainiops is not closely related to **Cerotainia**, **Atomosia**, or other genera of **Atomosiini** as indicated by its describer. It is most

closely related to the nearly cosmopolitan genus **Andrenosoma** Rondani, particularly because of the depressed proboscis which is but slightly upturned distally, and because of the strongly flattened second palpal segment. The wing venation of **Cerotainiops** is very similar to that of **Nusa** Walker (=**Dasythrix** Loew) in that the longitudinal veins attaining the posterior margin of the wing are evanescent distally. **Cerotainiops** further differs from **Andrenosoma** in that the facial tubercle is not abrupt above; the mystax is more or less tectiform, composed of rather dense bristles below and recumbent silky hairs above; the body and legs are not as hairy; the abdomen is robust, concealing the genitalia from above; the ovipositor is not compressed, the oviduct a very short, eversible tube. The third antennal segment of **Cerotainiops** is rather short, pyriform, the first posterior cell is closed and long petiolate. The species here included form a homogeneous group differing from each other principally in chaetotaxy, pollinosity pattern, somewhat in color, and only slightly in genital characters.

Genotype.—(**Cerotainiops rufiventris** Curran)= **C. abdominalis** (Brown). Original designation.

Key to Species

1. Scutellum with a fringe of short marginal hairs; thoracic pleura largely whitish pollinose, with a large spot behind the anterior coxa and a smaller spot behind the middle coxa bare of pollen and shining (N. Mex., Tex., Okla., Kans., Ariz., Calif) ----------**abdominalis** (Brown)
   Scutellum with one or two pairs of long marginal bristles; thoracic pleura entirely pollinose or largely bare of pollen----2
2. Thoracic pleura largely bare of pollen, shining; posterior femora blackish; hairs of proximal division of first abdominal segment black (Calif.) ----------**oma**, new species
   Thoracic pleura entirely pollinose; posterior femora largely orange, infuscated at distal end; hairs of proximal division of first abdominal segment whitish (Ariz., Calif.) ----------**wilcoxi**, new species

Cerotainiops abdominalis (Brown)

1897. **Nusa abdominalis** Brown, Kans. Univ. Quart., 6 (2): 103.
1897. **Nusa similis** Brown, Kans. Univ. Quart., 6 (2): 103. New synonmy.
1919. **Nusa abdominalis atripes** McAtee, Ohio Jour. Sci., 19 (4): 247 New synonmy.
1919. **Nusa similis** McAtee, Ohio Jour. Sci., 19 (4): 248.
1930. **Cerotainiops rufiventris** Curran, Amer. Mus. Nov., 415: 11. New synonmy.

1934. **Andrenosoma abdominalis** Bromley, Ann. Ent. Soc. Amer., 27: 84, 103.

1934. **Andrenosoma similis** Bromley, Ann. Ent. Soc. Amer., 27: 84.

1934. **Andrenosoma atripes** Bromley, Ann. Ent. Soc. Amer., 27: 84.

Types.—Of **abdominalis**, one female, Cuba, Bernalillo Co., New Mexico (Barnum Brown), which has apparently been lost; of **similis**, two females, Cuba, Bernalillo, Co., New Mexico (Barnum Brown), which has apparently been lost; of **atripes**, type, female, Mesilla, New Mexico, July 12, 1897 (Cockerell), in the United States National Museum; of **rufiventris**, holotpye, female, Coyote Mts., Arizona, August 4-7, 1916, in the American Museum of Natural History. Dr. Barnum Brown informed the author that the types of his species were deposited in Dr. Williston's collection. Dr. R. H. Beamer advised the author that these specimens were not recorded as being in the University of Kansas collection, and that they could not be located there.

Remarks.—C. **abdominalis** is a rather variable species with a wide range in the Southwest. The antennae are black or to a variable extent reddish; the oral bristles of the mystax white or sometimes black. The thorax is reddish or black in ground color, the pollen appearing denser in the black forms. The legs are black or with a proximal portion of the tibiae reddish, rarely with the femora somewhat reddish proximally. Each abdominal segment laterally has from one to four bristles There is no correlation of this variation either with sex or geographic distribution. Members collected at the same time and place may exhibit such differences. The hind tibia of the male is more strongly arcuate than in the female. Curran has given a good description of the species. The length is from 9 to 14 mm.

McAtee doubted whether **similis** was a distinct species. All of the differences which Brown brought out seem to be well covered by variations in the material at hand. It appears to be entirely reasonable to consider **similis** a synonym of **abdominalis**. The types of **atripes** and **rufiventris** have been examined by the writer and found to represent the same species.

Specimens examined.—KANSAS: one female, Comanche Co., 1916, 2089 ft. (R. H. Beamer). OKLAHOMA: four males, three females, Vinson, July 9, 1934 (A. E. Pritchard); one male, Wichita National Forest, June 27, 1932 (O. Sandoz). TEXAS: one male, one female, Girvin, August 4, 1931 (R. H. Painter). NEW MEXICO: two females, Luna Co., July 14, 1934 (R. T. Kellogg); one male, Organ, August 8, 1931; one female, Alamagordo, June 30, 1932 (J. D. Beamer); one female, White Sands, July 23, 1933 (W. Benedict). ARIZONA: one male, San Carlos Lake, July (D. K. Duncan); one

female, Continental, July 15, 1938 (Jean Russell); one female, Arivaca, July 12, 1940 (D. E. Hardy); one female, Tuscon, July 23, 1938 (Jean Russell). CALIFORNIA: one male, Los Angeles (D. W. Coquillett); four females, San Bernadino Co. (D. W. Coquillett).

Cerotainiops oma, new species

Black in ground color, the mesonotum in part and the abdomen reddish or orange; legs black, the tibiae yellowish proximally; wings infuscated along the veins. Length, 8 to 13 mm.

Male.—Head black, white pollinose; vestiture white; mystax silky on face above tubercle, with long bristles on lower part, the oral bristles on either side brownish; palpi black haired. Antennae brown, the pedicel of the third segment pale yellowish. Thoracic pleura black, the meso- and metapleura nearly entirely bare of pollen, metapleural bristles long, brownish; upper margin of mesopleura reddish, white pollinose, clothed with rather long white hairs; notum reddish in ground color, the mesonotum with a geminate middorsal vitta slightly widened anteriorly and falling short of the scutellum posteriorly, and with a large black lateral vitta narrowly broken by the transverse suture; pronotum bare of pollen on either side; mesonotum bare of pollen except peripherally, a pair of small dots on the median vitta at the transverse suture and another pair anterior to this, sparcely but entirely clothed with recumbent whitish setae and with whitish lateral bristles; scutellum with disc yellowish pollinose and sparsely setose, the posterior margin dark brownish, bare of pollen, with a pair of long marginal bristles and a much smaller inner pair. Legs blackish, the tibiae pale yellowish on proximal third, the tarsi castaneous; moderately clothed with whitish bristles and white hairs. Wings lightly infuscated, darker along the veins, irregularly hyaline along posterior border. Abdomen largely reddish; proximal division of the first segment blackish and clothed laterally with black or brownish hairs; rest of abdomen clothed with short, recumbent, yellowish-orange setae; lateral pale bristles on each segment one or two. Genitalia reddish, blackish at distal end.

Female.—Similar.

Holotype.—Male, Los Angeles, California (D. W. Coquillett), in the U. S. National Museum.

Allotype.—Female, Los Angeles, California (D. W. Coquillett).

Paratypes.—One male, Los Angeles, California, May (D. W. Coquillett); one female, Santa Anna, California, June 17, 1938 (John Standish).

Remarks.—C. **oma** is related to **abdominalis** from which it differs in having the thoracic pleura largely bare of pollen, shining; mesopleura above with long hairs; metapleurals usually black; pronotum bare of pollen on either side; mesonotum with the disc practically

bare of pollen with the black vittae well differentiated in the ground color; mesonotal pollen more broadly surrounding the anterior humeri and with only two pairs of small inner spots representing the transverse lines of **abdominalis**; scutellum with one pair of marginal bristles and a smaller inner pair; and proximal division of the first abdominal segment black with lateral hairs usually black. The oral bristles of the mystax may be black as is sometimes the case in **abdominalis.**

Cerotainiops wilcoxi, new species

1919. **Nusa abdominalis** McAtee (not Brown), Ohio Jour. Sci., 19 (4): 247. Misidentification.

Thorax black or reddish in ground color, white pollinose, thinly so on the vittae, white pilose. Abdomen orange. Legs orange, the tarsi, distal ends of the tibiae and femora black. Wings essentially hyaline. Length, 11 to 14 mm.

Male.—Head black, cinereous pollinose, with white hairs and bristles; mystax dense and silky above, with long bristles below. Antennae brownish, somewhat paler proximally. Thorax black in ground color, the coxae and mesonotum except for wide vittae rather reddish; pleura entirely white pollinose, the hairs and bristles white; pronotum entirely white pollinose; mesonotum entirely white pollinose but thinner on geminate median and wider lateral vittae which are poorly differentiated, clothed with white setae except on the vittae, and with white lateral bristles, 2 presutural, 3 supra-alar, and 4 postalar; scutellum white pollinose, more thinly so on caudal margin, thinly white setose, with one pair of long white scutellars and a smaller inner pair. Legs orange, the anterior four femora above on distal third, the posterior femora on distal fourth, anterior four tibiae on distal third, posterior tibiae except for proximal third, and tarsi all blackish; clothed with white hairs and whitish bristles. Wings hyaline. Abdomen orange, yellowish setose above, each segment with one or two bristles laterally. Genitalia blackish distally.

Female.—Similar, the anterior four femora blackish on distal half.

Holotype.—Male, Tempe, Arizona, July (D. K. Duncan), in the collection of the University of Minnesota.

Allotype.—Female, Tempe, Arizona, August (D. K. Duncan).

Paratypes.—Five males, nine females, Tempe, Arizona, July-August (D. K. Duncan); two females, Phoenix, Arizona, August (D. K. Duncan); one female, Scaton, Arizona, August 8, 1930 (T. F. Winburn and R. H. Painter); one male, one female, Blythe, California, September 16, 1938 (F. H. Parker).

This species is named in honor of Mr. Joseph Wilcox who independently came to similar conclusions regarding the previous

misidentification of this species and the synonymy of **rufiventris** and **atripes.**

Remarks.—**C. wilcoxi** is closely related to **oma** and to **abdominalis** from both of which it differs in having the hairs and bristles of the body entirely white, the mystax denser; the hairs and bristles longer, especially on the legs; the thorax entirely pollinose with the vittae bare of setae; the legs in large part orange; the wings essentially hyaline.

C. wilcoxi is variable in coloration of the thorax and legs to a considerable extent, much as in **abdominalis.** The thorax is often entirely black. The anterior four femora vary from black at the distal end above to entirely black in one female from Tempe; the posterior femora are in no case with over the distal third blackish; the anterior four tibiae may be black on the distal half, and the posterior tibiae may be nearly entirely black.

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NOTICE OF 18TH ANNUAL MEETING KANSAS ENTOMOLOGICAL SOCIETY

Due to a conflict of the Conference of Central States Entomologists with the meetings of the Kansas Academy of Science, the Kansas Entomological Society will be unable to meet with the Academy as has been the usual custom. Instead, the Society will hold their annual meeting at the Entomology Department, University of Nebraska, Lincoln, Nebraska on April 4.

All titles for papers to be presented at the meeting should be in the hands of the secretary not later than February 28. Please indicate the time requested for the presentation of the paper and whether or not a lantern is to be used.

D. A. WILBUR, Secretary

NOMOPHILA NOCTUELLA AS A GRASS AND ALFALFA PEST IN KANSAS (LEPIDOPTERA. PYRALIDIDAE).

ROGER C. SMITH
Kansas State Agricultural Experiment Station, Manhattan, Kansas[1]

Nomophila noctuella D. and S. has no generally accepted common name, but it has been referred to as the "celery stalk worm" in Florida and the "soil web worm" in Kansas. Both names however are regarded as unsuitable in view of its habits and relationships. This species is one of the common moths of minor importance occurring in alfalfa fields and grasslands in Kansas. These moths can be most easily collected at lights and by sweeping in alfalfa fields and pastures, from the middle of April to about October 1. A study of this insect was begun in connection with the alfalfa insect project since its larvae feed to some extent on alfalfa. This report is a summary of observations made on its life stages in the field and laboratory in Kansas since 1920. One of the particular difficulties encountered during the earlier years was the confusion of the larval stages and habits of Nomophila with those of **Crambus vulgivagellus** Clem., **Stenoma mistrella** Busck and **Acrolophus** sp. This paper includes the distinguishing characters of these larvae.

Review of Literature

This species of moth is widely distributed over the world according to published information. It has been specifically listed from Europe, Algeria, Brazil and the whole of the United States.

Flint (1922) published a brief account of the life history and habits of this species. He reported damage to newly seeded fields of sweet clover in Illinois in 1919. He stated that there was a possibility of four generations a year with an average of 50 days each beginning with the hibernating larvae. The chief food plants of the species according to Flint, are red and sweet clovers and alfalfa, but in a few cases the larvae had been found on blue grass, purslane, corn, wild mustard, cinquefoil, white clover, fox tail and soybeans. The similarity of their feeding habits to crambids was mentioned. Spraying sweet clover with arsenate of lead, 2 lbs. to 50 gallons of water gave complete control.

Ellis (1925) included a brief synonmy of this species in his summarized account of the life history and description of stages with reference to distinguishing the larva of Nomophila from the European corn borer. He reported two generations each year for New England and overwintering in the larval stage in litter. Moths emerged during the last week in May while the second generation of moths occurred during July. "The larvae are taken

[1]Contribution No. 504 from the Department of Entomology.

commonly from celery on the grooved side of the celery stalk and also apparently preferred the blanched and semi-blanched portions of the stalk. Only the outermost stems of the plant were observed to be infested." The damage was done by eating irregular shallow excavations on the stalk usually covering the area with silk. He stated that the larvae were surface feeders and did not burrow into the stalk. They moved equally well backward or forward in their burrows when prodded.

Drake and Decker (1927) stated that this world-wide moth was an occasional pest of little importance to legumes, bluegrass, foxtail, celery, corn and a number of other plants. They stated that there were probably three or four generations in the state of Iowa. Felt (1922) noted that the larvae fed mainly on legumes and had been found feeding in a few cases on blue grass, purslane, corn, wild mustard, cinquefoil and foxtail. Caffrey and Worthley (1922), Ellis (1925), Drake and Decker (1927), and Hutson (1934) reported the larvae as occurring and feeding on celery.

Observations on the Life History in Kansas

The moth has first appeared during these observations in the early part of April. They dart up from their hiding places when disturbed and fly erratically for several rods, alighting on a plant and quickly gaining cover by crawling on the under side of a leaf. The moth with folded wings appears (Fig. 2) relatively long and slender. It measures 12-17 mm. in length and has a wing spread of about 25 mm. The forewings are light brown or grayish-brown with three indefinite, chocolate brown, transverse bands. The under side of the costal margin of the forewing has four, generally prominent, equally spaced, black dots from the middle to the apex. Pinned and most field specimens are generally so badly rubbed that most wing spotting and bands are obscured. The wings when at rest are usually held transversely over the abdomen and the tips of the forewings generally overlap one another. The under side of newly emerged moths is lightly gray with three narrow longitudinal, brownish stripes on the abdomen, one in the mid-ventral line and a pair lateral to this one. These stripes can be seen through the pupal skin prior to the moth emergence. The head and thorax of rubbed specimens are shining, dark reddish-brown in color. Adults were never observed feeding in the field nor were they attracted to flowers.

The eggs of **N. noctuella** were glued to the substratum singly, in masses, or in rows, the latter predominating. The maximum egg deposition varied from about 80 to 142, the latter being the largest number obtained from any one female. The deposited eggs (Fig. 1) were variously shaped, generally oblong ovate, flattened

below and often somewhat angulate. When deposited in rows, they suggested a minature rope. The chorion was covered with a fine, mesh-like net-work and was highly iridescent, these reflections being quite marked. They were light green when first laid and changed to reddish-brown as embryonic development proceeded, eventually becoming almost black. The average size of ten eggs was 0.6 mm. in greatest diameter and 0.36 mm. smallest diameter.

The eggs hatched in 3 to 4 days in mid-summer. Flint (1922) observed an average egg period of 6 days. The larvae, immediately after hatching, began feeding on the epidermis of one side of the leaves of alfalfa, but later skeletonized the leaf. They also began at once to make small horizontal shelter tubes about the base of the plant. These consisted of silken webbings which incorporated particles of soil or small bits of rubbish just below or at the ground level. With respect to the webbing, they have the same general habits as "sod webworms" such as **Crambus vulgivagellus**, which is the common crambid in Kansas. The larvae spent the greater share of time within these shelter-tubes and were observed to cut off leaves and drag them to the shelter tubes where they fed upon them, while only their heads were exposed to view. The larvae were never taken by sweeping in the fields. They did not leave their shelter tubes except when disturbed or conditions were unfavorable to them.

The fully grown larva (Fig. 3) was somewhat grayish or greenish in color with prominent black spots on the body. The head capsule was black and the cervical shield was chestnut brown. Two rows of prominent black spots, four to a segment, occurred on the dorsal surface of the larvae, a row each side of the dorsal vessel. An unusually long seta arose from the center of each black spot. There was a second row of subdorsal black spots consisting of one pair of spots to each segment ventrad to the dorsal row. The spots were often irregular in outline and were always bordered by a narrow gray area. On the last two segments, the two dorsolateral spots occurring on each side of the other segments were fused into one. It was also margin'd by a narrow whitish area. There were four pairs of abdominal prolegs and a pair of anal prolegs.

The larvae were quite active, travelling backward and forward in their silken tunnels with equal facility. They molted five times and reached maturity under rearing conditions in about a month. Table I gives a summary of measurements for recognition of the various instars, while Table II gives a summary of molts and the length of the stages.

When larvae matured, under laboratory conditions, they spun

a cocoon which was only slightly larger than the pupa. Their cocoons incorporated bits of leaves and soil on the outside and had an inner, thin layer of silk which covered the pupa. The cocoons differed from those of **Crambus vulgivagellus** in that they were

Table I. Summary of measurements of 16 larvae of **Nomophila noctuella** for recognition of the different instars.

	Width of Head Capsule			Total Length		
	Least mm.	Greatest mm.	Average mm.	Least mm.	Greatest mm.	Average mm.
First Instar Larva	0.23	0.25	0.24	2	2.2	2.04
Second Instar Larva	0.34	0.37	0.35	2.2	3.5	2.7
Third Instar Larva	0.55	0.65	0.58	5.5	7.5	6.18
Fourth Instar Larva	0.80	0.87	0.84	9	12	9.42
Fifth Instar Larva	1.10	1.30	1.14	15	25.5	17.3
Sixth Instar Larva	1.76	1.85	1.80	23.2	27.2	24.75

Table II.—Summary of Length of Stages of **Nomophila noctuella** reared in the field laboratory during May and June.

	Average Days	Maximum Days	Minimum Days	Number of Formed averaged
Egg Stage	3	4	3	35
First Instar Larva	3.1	6	3	30
Second Instar Larva	2.3	4	1	30
Third Instar Larva	2.83	7	2	30
Fourth Instar Larva	2.3	7	1	29
Fifth Instar Larva	2.46	3	1	26
Sixth Instar Larva	4.33	8	1	24
Prepupa	1.37	2	1	24
Pupa	9.1	10	8	24

smaller, more loosely woven and were formed on a level with the surface of the ground. Cocoons of C. **vulgivagellus** were longer than those made by Nomophila, more tightly woven and usually occurred in a vertical position in the ground. **Stenoma mistrella** made similar cocoons also, but they differed from those of **N. noctuella** in that they were situated within the grass clump, the stems of which served to support the silken case. Pale green fecal material was usually present also near the upper end of these cocoons and they were never found below the ground. **Acrolophus** larvae constructed in the alfalfa fields vertical, silken tunnels two to five inches long which could readily be confused with **N. noctuella.** Often the empty pupal skins of **Acrolophus** were found protruding from the openings of these silken tunnels at the surface of the soil.

There was a prepupal period in **Nomophila** of about a day. The pupa (Fig. 4) measured from 3 to 3.5 mm. in diameter at the widest place and from 13 to 14 mm. in length. It was greenish in color for a day or two, gradually turning reddish-brown, but the posterior

portion generally remained yellowish-brown.

Newly emerged **Nomophila** adults had a more brilliant and sharply defined color pattern than characterized moths taken in the fields. Felt (1893) pointed out that four-fifths of the moths taken at lights were males. In these rearings, there was 16 males to 6 females indicating probably an excess of males in nature.

Egg deposition was begun within two or three days following emergence. Copulation occurred any time after emergence. The moths could be kept alive for as much as two weeks in cages by feeding them on dilute sugar water.

There was evidence of two generations in Kansas. The first generation occurred during late spring and early summer and the second during late summer or after the hot weather. Felt (1893) found three in New York, and Flint (1922) reported four in Illinois. It has been difficult to follow this insect with any degree of accuracy in the field because moths were present nearly continuously from the early part of April until late October. The authors mentioned above stated that the species overwintered as partly grown larvae in tunnels. No data could be obtained on this point in Kansas, but early occurrence of adults appears to indicate overwintering as larvae.

Table III shows larval differences of the species which may be confused with **Nomophila.**

Feeding habits of Nomophila larvae

This species was present on several occasions when extensive insect damage was done to grass lands during April, May and June in Kansas. There is no evidence that they were wholly responsible for any observable, serious damage to grass or alfalfa. The larvae appeared to have overwintered in the thick mats of grass and did their injury in the spring by devouring the early green growth when they completed their growth. Such injury has often been mistaken for cut worm and army worm damage.

One of the earlier reports of extensive injury to which Nomophila contributed occurred at Great Bend, Kansas, the latter part of April, 1932 in a field of 40 acres of June grass (prob. **Koeleria cristata** (L)). From the description, it appears that all the green foliage was destroyed and that the larvae ate for a time on the roots of dead stems. However, most of them migrated and gave the field the appearance of waves of devastation moving across the field. Larvae of Crambids also occurred in the field but they perhaps were second in importance. The injury was comparable to a severe attack of army worms. Franklin gulls ate many of the larvae following harrowing the field.

The second instance of injury in which this species was concerned with Crambids occurred at Williamsburg, Kansas, the latter part of April, 1938. A field of approximately 40 acres of blue grass

TABLE III*

Identification characters of the species of caterpillars in Kansas likely to be confused with **Nomophila.**

Name	General coloration	Arrangement of spots and stripes	Head and Cervical Shield	Crochets	Differences in setal pattern on abdominal segments VIII and IX	Length of clypeus	Texture of head capsule	Shape of frons.
Nomophila noctuella	Grayish with black spots	Seta bearing spots arranged in 4 longitudinal rows —4 spots to each segment on the dorsal surface arranged as a square; a pair also on each segment laterad constitutes the two outer rows.	Head shining black; cervical shield dark brown	Tri-ordinal hooks	AVIII has setae IV and V located above setae VI. AIX has setae I and V absent.	2/3 length of head capsule. Basal border slightly concave.	Smooth	Follows the clypeal border very closely.
Crambus vulgivagellus	Grayish brown with black spots	Seta bearing spots somewhat staggered so that definite longitudinal rows are observable. Variation in shape and number of other setal spots within the species occurs.	Black head and cervical shield. Color varies in other species of same genus.	Tri-ordinal hooks	AVIII has setae IV and V in front of seta VI. AIX has setae I absent and setae IV and V are combined.	2/3 length of head capsule. Basal border straight.	Smooth	Narrow with a light band on lateral and dorsal edges.

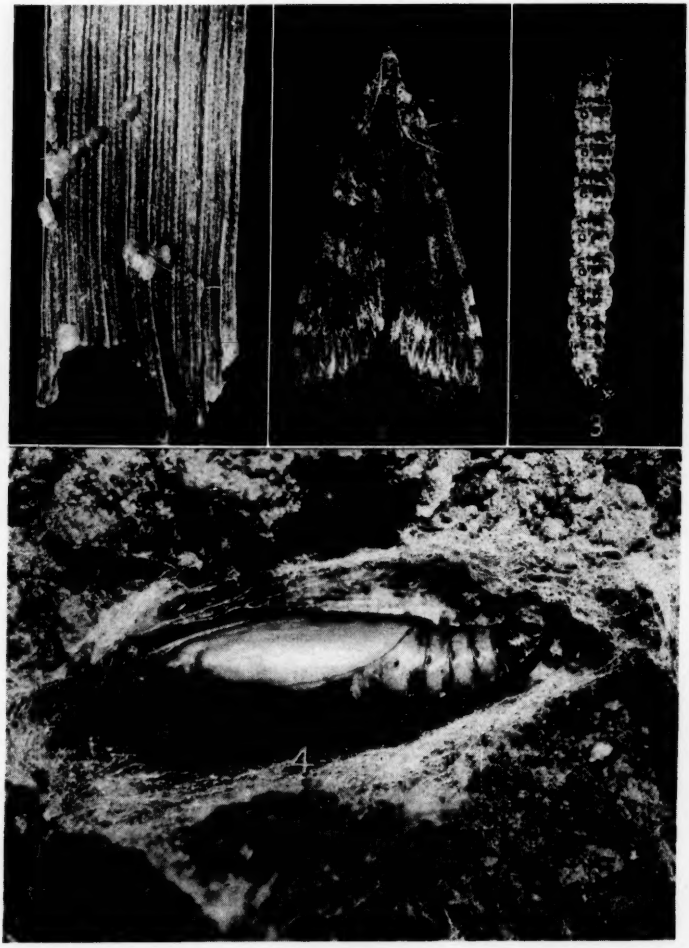
TABLE III (Concluded)

TABLE III (Concluded)

Identification characters of the species of caterpillars in Kansas likely to be confused with **Nomophila noctuella**

Name	General coloration	Arrangement of spots and stripes	Head and Cervical Shield	Crochets	Differences in setal pattern on abdominal segments VIII and IX	Length of clypeus	Texture of head capsule	Shape of frons.
Stenoma mistrella	Pinkish-brown with longitudinal stripes	One longitudinal stripe on dorso-median surface and two smaller lateral stripes. Spots are also present which are somewhat staggered and much smaller than in C. vulgivagellus and N. noctuella.	Head and cervical shield deep chestnut brown. Cervical shield has a light band on anterior border.	Tri-ordinal hooks	AVIII has setae IV and V in front of seta VI. AIX has setae I and V present.	1/3 length of head capsule. Basal border slightly concave.	Dark brown blotches, scale-like.	Dorsal half contiguous. Ventral half wide.
Acrolophus sp.	Solid coloration of light brown having a velvety appearance.	No stripes nor spots.	Black head and cervical shield. Head usually partly retracted under cervical shield.	Single row of hooks	AVIII has setae IV and V back of setae VI. AIX has all setae present. Two individual setae combine to form seta VII.	1/2 length of head capsule. Basal border straight.	Deep half moon fissures	Wide with lateral and medial edges inverted V-shaped.

*Prepared by H. D. Oliver Miller



EXPLANATION OF PLATE

1. Eggs of **Nomophila noctuella** D. and S. deposited in cages. They are glued to a blade of grass.
2. Recently emerged moth of the above species.
3. Dorsal view of the full grown larva of **Nomophila noctuella.** Note the six spots per segment and the two dorsal longitudinal rows which they form.
4. Pupa of the same species. The inner silken cocoon has been cut open to expose the pupa.

and wild oat pasture was wholly destroyed. Overwintering larvae spread from the old grass sod where they had wintered and ate every spear of grass in the field. Specimens of the larvae were identified from the field as this species. There were some other web worms and cut worms in the field also, but identification of them was not possible. The correspondent spoke of the larvae living in webbing around the base of the plant. Such injury had not previously occurred in the region. An attempt to destroy them by burning was unsuccessful. The land was disked and put in Sudan grass.

A third instance of destruction and of severe damage presumably by this species occurred in a 20-acre pasture at Abilene, May 9, 1938. Larvae were not seen but the description of the webbed tubes on the ground around the grass clumps and of the larvae retreating backwards into the tubes when disturbed, strongly suggested this species. Plowing up or disking and planting to sorghum was recommended where the damage was severe.

Serious injury was done to 30 acres of pasture near the western border of Osage County in early June, 1938. All the larvae had developed to moths when the pasture was visited but **Nomophila** moths were exceptionally plentiful. The owner stated that on several occasions a week or 10 days earlier, a layer of dead moths said to have been of the flying species covered the water tank each morning. An oats field and a neighboring pasture of 160 acres were also damaged but buffalo grass in the pastures appeared to be uninjured. White grubs were present in small numbers only.

Larvae were seen from the first two fields but at the time the writer could not distinguish between larvae of **Nomophila** and **Crambus**. Recent re-examination of the preserved larvae indicated that both species had been present. In the laboratory, **Nomophila** larvae placed on potted plants of brome grass and Kentucky blue grass failed to mature, while the larvae under similar conditions on potted alfalfa plants grew to maturity. They also fed on the brome grass, but no signs of feeding could be found on the Kentucky blue grass.

The moths are often common in alfalfa fields but no damage to this crop in the field has been observed. No opportunities for field observations near at hand and control experiments have been available. The importance of **Nomophila** in Kansas is that it is a potential pest of consequence to alfalfa and some grasses.

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A NOTE ON LEAFHOPPER ABUNDANCE

While scouting for Pear Psylla in Yakima Valley, Washington, this fall the writer and Mr. F. C. Harmston made an interesting observation of insect nuisance due to abundance.

At White Swan, Washington, the townspeople were caused a great deal of annoyance during the latter part of October and the first few weeks in November by the presence in enormous numbers of a large leafhopper, **Cicadella hieroglyphica** var. **confluens** (Uhler). This species became so abundant around the vacinity that the trees, sides of houses, buildings, fence posts, etc. would be blackened by them. Each time a person opened a door the leafhoppers swarmed into the houses. One man had attempted to paint his house and the insects became lodged by the thousands in the white paint. The town is apparently confronted with this situation each fall and the residents have become so concerned about it that they are attempting to raise a fund to cover the cost of eradication of this leafhopper in that community.

The region is arid, with few trees except in the town and as the leafhoppers are in flight preparing to enter winter quarters the village becomes a focal point for their swarms, as that is the most likely place for them to find shelter. A small creek runs through the town and the swale is lined with willows, this is apparently the source of infestation as P. W. Oman states that this species lives entirely on willows.

D. ELMO HARDY, Lawrence, Kansas

A NOTE ON ADELOCEPHALA BICOLOR (HARR.)
(Lepidoptera: Saturnioidea)

DON B. STALLINGS and DR. J. R. TURNER, Caldwell, Kansas

Adelocephala bicolor (Harr.). This species with its various forms is triple brooded in south-central Kansas. It appears from the notes that follow that as a general rule each brood has physical characteristics by which it may be determined.

Adelocephala bicolor f. suprema (Neum.). This is the vernal or spring form of **bicolor.** Unfortunately when this form was described an intermediate specimen was used which had the characteristics of both the spring and summer form. **Suprema** was described as having the head, thorax, abdomen and legs pearly grey, with the primaries brown, shading into pearl grey. Actually the normal coloring of the spring form is for the ground color of both body and wings to be grey without any brown at all, the grey tending more to smoke than to pearl. **Bicolor** has the ground color a yellowish-brown, both **bicolor** and **suprema** have the upper surfaces of the forewigs and the under surfaces of the hindwings speckled with darker coloring. We have seen the spring form occur without the speckling on the wings. There are all kinds of intergrades between **bicolor** and its form **suprema.** We have specimens that are normal **bicolor** in every respect except that the legs are grey. On the other hand we have specimens that are of the normal spring form except that the abdomen is yellowish-brown. This spring form flies from April 25th to May 15th, however we have a single specimen taken August 23rd. Wing expanse of the male varies from 35 mm. to 48 mm. with 45 mm. being the average. Wing expanse of the female varies from 49 mm. to 65 mm. with 56 mm. being average.

Adelocephala bicolor f. immaculata (Jewett). This form differs from **bicolor** in lacking the darker speckling on the wings, hence its name. The ground color is a lighter yellowish-brown than is **bicolor.** This form normally occurs in the first summer brood which flies from June 20th to July 10th, although we have specimens taken as late as August 23rd. From breeding experiments it appears that approximately 50% of the first summer brood are typical of form **immaculata** and the remaining specimens have lighter ground color and much less of the dark speckling than does **bicolor.** Unfortunately we have not been able to take sufficient specimens in nature of this first summer brood to determine whether the above mentioned percentage holds true in nature. Wing expanse of the male varies from 32½ mm. to 50½ mm. with 37 mm. being the average. Wing expanse of the female varies from 40 mm. to 47 mm. with 45 mm. being the average.

Adelocephala bicolor (Harr.). This is normally the second summer brood flying from August 10th to Sept. 2nd, although we have specimens taken as early as May 17th. It is interesting to note that although both honey-locust and coffee-bean trees (the two food plants of **bicolor**) occur in this vicinity, we have no evidence that they ever feed on honey-locust; all larvae and ova that we have found in nature were on the coffee-bean tree. We plan some experiments this coming season with honey-locust. Wing expanse of the male varies from 35 mm. to 52 mm. with the average at 43½ mm. Wing expanse of the female varies from 44 mm. to 62 mm. with the average at 55 mm.

RACIAL VARIATION IN HEMIARGUS ISOLA (REAKIRT) (Lepidoptera: Lycaenidae)

WILLIAM D. FIELD, Lawrence, Kansas*

The writer has recently had the opportunity of studying a series of thirty specimens of **Hemiargus isola** (Reakirt) taken on September 23rd, 1938 at Rio del Monte in the state of Hidalgo, Mexico by L. J. Lipovsky. A comparison of this series with a large series from Kansas, Texas and Colorado and from Naica in the state of Chihuahua, Mexico and Chapula and Cocula in the state of Jalisco, Mexico clearly shows to distinct subspecies.

Typical **isola** was described by Reakirt[1] from near Vera Cruz, Mexico. This name will apply to the Rio del Monte specimens. The name **Lycaena alce** Edwards[2] based upon specimens of this species from Colorado[3] is available for the subspecies found in the United States and northern and western Mexico.

Typical **isola** is slighlty larger than **alce**, having a wing expanse in the male sex of 24 millimeters. The one female in the series from Rio del Monte has an expanse of 27 millimeters. A series of typical **alce** from Colorado, Kansas and Texas and from the states of Chihuahua and Jalisco in Mexico was measured and found to have an average expance of 22 millimeters in the male sex and 24 millimeters in the female sex.

The most striking difference between the two subspecies is in the ground color on the undersurfaces. In typical **isola** it is a dark grey while in **alce** this color is brownish grey, sometimes almost white. The palpi, underside of thorax and abdomen in **alce** are white, in **isola** grey.

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*Contribution from the Department of Entomology, University of Kansas.

[1]Pr. Acad. Nat. Sci. Phil., p. 332, 1866.

[2]Tr. Am. Ent. Soc., 3, p. 272, 1871.

[3]F. Martin Brown, places the locality of Edwards' type specimens, collected by T. L. Mead, as Turkey Creek, Jefferson Co. and Georgetown, Clear Creek Co., Colorado. See, Jr. N. Y. Ent. Soc., XLII, p. 162, June, 1934.

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